

## OFFICE OF THE CHIEF TECHNOLOGIST

# SPACE TECHNOLOGY RESEARCH FELLOWSHIPS

Presentation at the NASA Advisory Council Technology and Innovation Committee Meeting

**November 18, 2011** 

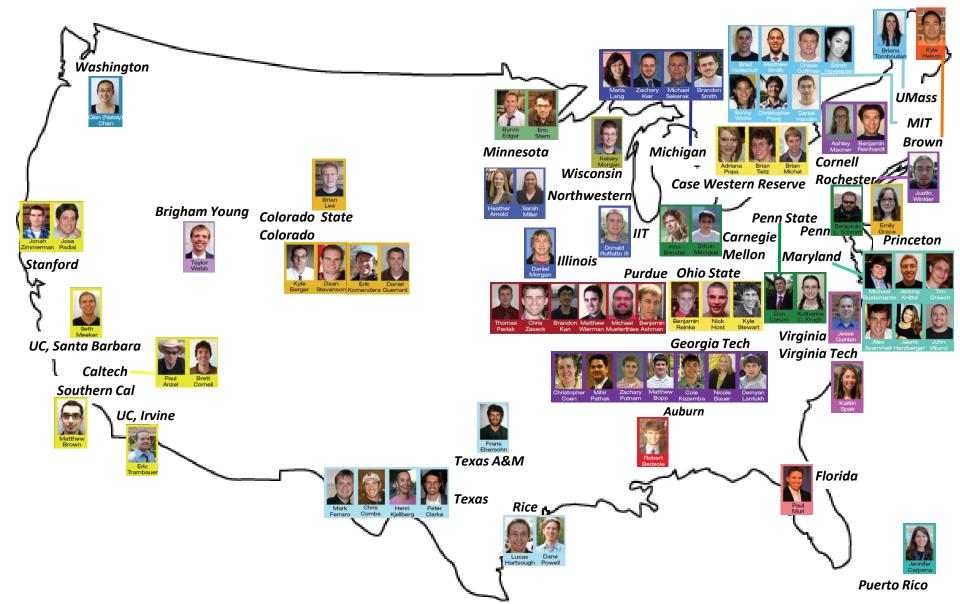
Claudia Meyer
Space Technology Research Grants Program Executive

www.nasa.gov

# **National Asset: The Inaugural Class of NSTRF**



## 80 Students - 37 Universities - 22 States and U.S. Territories



## **NSTRF Core Values**



"NASA Space Technology Fellows will perform innovative space technology research while building the skills necessary to become future technological leaders."

July 27, 2011

RELEASE: 11-246

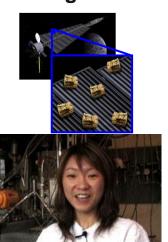
NASA Awards Space Technology Research Fellowship Grants

http://www.nasa.gov/home/hqnews/2011/jul/HQ 11-246 STRF Awards.html

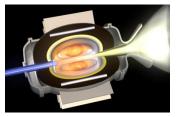
# **Space Technology Research Grants - Program Overview**



## **Level II Program Office: GRC**







**Objective:** Accelerate the development of push technologies through innovative efforts with high risk/high payoff

- Early Stage Innovation -Space Technology Research Opportunities (ESI-STRO): Low TRL technology portfolio for groundbreaking research in advanced space technology
- NASA Space Technology Research
   Fellowships (NSTRF): Competitive selection of
   U.S Citizen / permanent resident graduate students
   developing promising technologies in support of future
   NASA missions and strategic goals

## **Acquisition Strategy**

- ESI-STRO: NRA solicitation expected annually. Awards are grants, cooperative agreements, contracts or intra-agency transfers.
- NSTRF: Annual solicitation consistent with academic calendar. Awards are training grants to accredited U.S. universities. Selected candidates perform graduate student research on their respective campuses, at NASA Centers and notfor-profit Research and Development (R&D) labs.

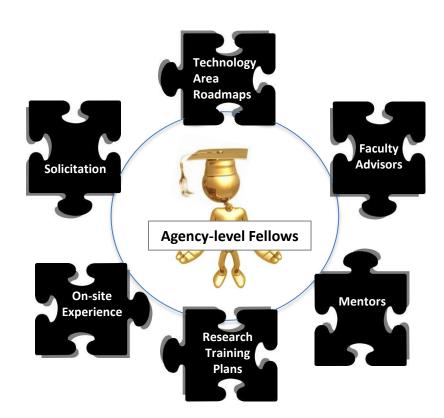
## **Awards**

- ESI-STRO: Typical 12 months awards at \$250K.
   100+ per year.
- NSTRF: 80 Fellows in inaugural year. NSTRF12 released on 11-4-11

## Collaboration

- ESI-STRO: Proposals welcome from all sources, including academia, industry, all U.S. government agencies and non-profit organizations; teaming encouraged
- NSTRF: Each student is matched with a professional advisor at NASA Centers or R&D Lab

# The "Pieces" of the NASA Space Technology Research Fellowships



## The Solicitation - Introduction



## NASA SPACE TECHNOLOGY RESEARCH FELLOWSHIPS (NSTRF) - Fall 2012 Fellowship Start

| Call for applications              | November 4, 2011         |
|------------------------------------|--------------------------|
| Applications due                   | January 11, 2012 at      |
|                                    | 6:00 PM ET               |
| Fellowship selection notifications | Late April 2012 (target) |
| Fellowship acceptance deadline     | Notification + 7 days    |
| Start date of fellowships          | August 1, 2012 (target)  |

## The solicitation is available by

- opening the NASA Research Opportunities homepage at <a href="http://nspires.nasaprs.com/">http://nspires.nasaprs.com/</a>,
- selecting "Solicitations,"
- > then selecting "Open Solicitations," and,
- finally, selecting "NSTRF12."

## **Minimum Eligibility Requirements for NSTRF12**

- 1. Pursuing or seeking to pursue advanced STEM degrees.
- 2. U.S. citizens or permanent residents of the U.S.
- 3. Have or will have a Bachelor's degree prior to the fall of 2012.
- 4. Are or will be enrolled in a full-time Master's or Doctoral degree program at an accredited U.S. university in fall 2012 (awards may not be deferred).
- 5. Have completed no more than twenty-four months of full-time graduate study as of August 1, 2011. Full-time graduate study is as defined by the universities attended. Applicants who have completed part-time graduate study must have completed no more than 30 semester hours or 45 quarter hours, or their equivalent, as of August 1, 2011; this credit hour limit applies to part-time graduate students.

NSTRF<u>11</u> (inaugural year) documents are available at <a href="http://tinyurl.com/NSTRF11-OCT">http://tinyurl.com/NSTRF11-OCT</a>.

# The Solicitation – Application Components



The student shall be the principal author of the Educational Research Area of Inquiry and Goals, with minimal assistance from the current/prospective faculty advisor.



## **Educational Research Area of Inquiry and Goals**

- summary of educational program objectives
- research interests with associated relevant hypotheses and possible approaches
- benefits of proposed research
- benefits of on-site R&D lab experience





## Schedule of degree program

- proposed start and completion dates
- anticipated milestones



## **Statement from faculty advisor (one page)**

- planned use of faculty advisor allowance
- If applicable, brief description of ongoing or pending research awards from NASA that are related to the student's Educational Research Area of Inquiry and Goals.



## **Transcripts**

- undergraduate
- graduate



## Curriculum Vitae (one page)

- faculty advisor
- student



## Three signed letters of recommendation

- from academic advisor
- from other faculty members or professionals with detailed knowledge of student's abilities



**GRE** general test scores

# The Solicitation - Basis for Inspiration

















#### SOLID ROCKET PROPULSION SYSTEMS Propellants

- Case Materials Nozzle Systems
- Hybrid Rocket Propulsion Systems Fundamental Solid Propulsion
- Technologies LIQUID ROCKET PROPULSION

## LH\_/LOX Based

- RP/LOX Based CH /LOX Based · Detonation Wave Engines
- (Closed Cycle) Propellants Fundamental Liquid

#### Propulsion Technologies AIR BREATHING PROPULSION

#### SYSTEMS TBCC

- · RRCC Detonation Wave Engines (Open Cycle)
- Turbine Based Jet Engines (Flyback Boosters) Ramjet/Scramjet Engines
- (Accelerators) Deeply-cooled Air Cycles
- Air Collection &
- Enrichment System Fundamental Air Breathing Propulsion Technologies

## ANCILLARY PROPULSION

- Auxiliary Control Systems Main Propulsion Systems (Excluding Engines) Launch Abort Systems Thrust Vector Control Systems
- Health Management & Flywheels Pyro & Separation Systems

#### Fundamental Ancillary Propulsion Technologies

#### UNCONVENTIONAL / OTHER PROPULSION SYSTEMS

- Ground Launch Assist Air Launch / Drop Systems Space Tether Assist
- Beamed Energy / Energy
- Addition
- High Energy Density Materials/Propellants

## TA02 · IN-SPACE PROPULSION **TECHNOLOGIES**

- CHEMICAL PROPULSION Liquid Storable
- Liquid Cryogenic
- Solid Hybrid
- Cold Gas/Warm Gas Micro-propulsion
- NON-CHEMICAL PROPULSION · Electric Propulsion
- Solar Sail Propulsion Thermal Propulsion . Tether Propulsion
- ADVANCED (TRL <3) PROPULSION **TECHNOLOGIES**
- Beamed Energy Propulsion Electric Sail Propulsion
- Fusion Propulsion High Energy Density Materials Antimatter Propulsion
- Advanced Fission Breakthrough Propulsion

#### SUPPORTING TECHNOLOGIES Engine Health Monitoring & Safety

- Propellant Storage & Transfer
- Materials & Manufacturing Technologies
- Heat Rejection Power

#### SPACE POWER & TAO3 • SPACE POWER & ENERGY STORAGE

#### POWER GENERATION

- Energy Harvesting
- Chemical (Fuel Cells, Heat Engines) Solar (Photo-Voltaic & Thermal) Radioisotope
- Fission
- Fusion
- **ENERGY STORAGE** Barreries
- Regenerative Fuel Cells POWER MANAGEMENT &

#### DISTRIBUTION

- Management & Control
- Distribution & Transmission Wireless Power Transmission Conversion & Regulation

#### CROSS CUTTING TECHNOLOGY

- Analytical Tools Green Energy Impact
- Multi-functional Structures Alternative Fuels

### TA04 \* ROBOTICS, TELE-ROBOTICS & AUTONOMOUS SYSTEMS

- SENSING & PERCEPTION
- Tactile Sensing Arrays Gravity Sensors & Celestial Nav. Terrain Relative Navigation Real-time Self-calibrating of Hand-eve Systems

- Simultaneous Localiz. & Mapping Hazard Detection Algorithms Active Illumination 3-D Path Planning w/ Uncertainty Long-life Extr. Enviro. Mechanisms
- Robotic Jet Backpacks Robot Swarms
- Walking in Micro-g MANIPULATION
- Motion Planning Alg., High DOF Sensing & Control Robot Arms (light, high strength) Dexterous Manipul.. Robot Hands Sensor Fusion for Grasping
- Grasp Planning Algorithms Robotic Drilling Mechanisms Multi-arm / Finger Manipulation Planning with Uncertainty
- HUMAN-SYSTEMS INTEGRATION Crew Decision Support Systems Immersive Visualization
- Distributed Collaboration Multi Agent Coordination

#### Haptic Displays Displaying Range Data to Humans ALITONOMY

- Spacecraft Control Systems Vehicle Health, Prog/Diag Systems Human Life Support Systems Operations
- Planning/Scheduling Resources Integrated Systems Health Management
- FDIR & Diagnosis System Monitoring & Prognosis V&V of Complex Adaptive Sys's Automated Software Generation Software Reliability

#### Semi Automatic Systems AUTON. RENDEZVOUS & DOCKING

- · Rendezvous and Capture Low impact & Androgenous Docking Systems & Interfaces
- Robust AR&D GN&C Algorithms & FSW

#### Onboard Mission Manager AR&D Integration & Standardiz.n RTA SYSTEMS ENGINEERING

- Human safety Refueling Interfaces & Assoc. Tools Modular / Serviceable Interfaces High Perf., Low Power Onboard
- Environment Tolerance Thermal Control Robot-to-Suit Interfaces Common Human-Robot Interfaces Crew Self Sufficiency

#### TA05 COMMUNICA & NAVIGATION COMMUNICATION

#### OPTICAL COMM. & NAVIGATION

- Detector Development
- Large Apertures Lasers Acquisition & Tracking
- Atmospheric Mitigation RADIO FREQUENCY COMMUNICATIONS
- Spectrum Efficient Technologies
- Power Efficient Technologies Propagation Flight & Ground Systems

#### · Earth Launch & Reentry Comm. Antennas

- INTERNETWORKING · Disruptive Tolerant Networking Adaptive Network Topology
- Information Assurance Integrated Network Management
- Position, Navigation, and Timing Timekeeping Time Distribution
- Onboard Auto Navigation & Maneuver Sensors & Vision Processing Systems
- Relative & Proximity Navigation Auto Precision Formation Flying
- Auto Approach & Landing INTEGRATED TECHNOLOGIES
- Radio Systems Ultra Wideband Cognitive Networks
- Science from the Comm. System Hybrid Optical Comm. & Nav. Sensors
- RF/Optical Hybrid Technology REVOLUTIONARY CONCEPTS
- X-Ray Navigation X-Ray Communications Neutrino-Based Navigation & Tracking
- Quantum Key Distribution ntum Communications
- SQIF Microwave Amplifier Reconfigurable Large Apertures

## TA06 • HUMAN HEALTH, HABITATION SYSTEMS

## **ENVIRONMENTAL CONTROL & LIFE**

- SUPPORT SYSTEMS & HABITATION SYS. Air Revitalization
- Water Recovery & Management Waste Management
- Habitation EXTRAVEHICULAR ACTIVITY SYSTEMS
- Pressure Garment Portable Life Support System
- Power, Avionics and Software HUMAN HEALTH & PERFORMANCE
- Medical Diagnosis / Prognosis Long-Duration Health Behavioral Health & Performance

#### Human Factors & Performance ENVIRONMENTAL MONITORING, SAFETY & EMERGENCY RESPONSE

- Sensors: Air. Water, Microbial, etc. Fire: Detection, Suppression Protective Clothing / Breathing
- RADIATION Risk Assessment Modeling Radiation Mitigation
- Protection Systems Space Weather Prediction Monitoring Technology

#### TA07 · HUMAN EXPLORATION **DESTINATION SYSTEMS**

IN-SITU RESOURCE UTILIZATION

- Destination Reconnaissance, Prospecting, & Mapping Resource Acquisition
- Consumables Production Manufacturing & Infrastructure Emplacement

#### SUSTAINABILITY & SUPPORTABILITY

- Logistics Systems Maintenance Systems
- Repair Systems "ADVANCED" HUMAN MOBILITY
- SYSTEMS EVA Mobility Surface Mobility
- Off-Surface Mobility "ADVANCED" HABITAT SYSTEMS
- · Integrated Habitat Systems Habitat Evolution MISSION OPERATIONS & SAFETY
- Crew Training Environmental Protection Remote Mission Operations

#### Planetary Safety CROSS-CUTTING SYSTEMS

 Modeling, Simulations & Destination Characterization Construction & Assembly Dust Prevention & Mitigation

#### TAO8 · SCIENCE INSTRUMENTS. **OBSERVATORIES & SENSOR** SYSTEMS

## REMOTE SENSING INSTRUMENTS /

- SENSORS Detectors & Focal Planes
- Electronics
- Optical Components Microwave / Radio Lasers
- Cryogenic / Thermal **OBSERVATORIES**
- Mirror Systems Structures & Antennas Distributed Aperture
- IN-SITU INSTRUMENTS / SENSOR · Particles: Charged & Neutral
- Fields & Waves • In-Situ









#### TA09 • ENTRY, DESCENT & LANDING SYSTEMS ENTRY, DESCENT &

#### AEROASSIST & ATMOSPHERIC ENTRY

- Rigid Thermal Protection Systems COMPLITING Flexible Thermal Protection Systems · Flight Computing
- Rigid Hypersonic Decelerators Deployable Hypersonic Decelerators Instrumentation & Health Monitoring
- Entry Modeling & Simulation Attached Deployable Decelerators
- Trailing Deployable Decelerators Supersonic Retropropulsion GN&C Sensors Descent Modeling & Simulation
- Touchdown Systems
- Egress & Deployment Systems Propulsion Systems
- Large Body GN&C Small Body Systems Landing Modeling & Simulation
- VEHICLE SYSTEMS TECHNOLOGY Architecture Analyses
- Separation Systems System Integration & Analyses
- Atmosphere & Surface Characterization

#### TA12 • MATERIALS, STRUC-TURES, MECHANICAL NANOTECHNOLOGY SYSTEMS & MANUFACTURING

#### **ENGINEERED MATERIALS & STRUCTURES**

- · Lightweight Structures Damage Tolerant Systems
- Coatings Adhesives
- Thermal Protection & Control **ENERGY GENERATION & STORAGE**
- · Energy Storage
- Energy Generation **PROPULSION**
- Propellants Propulsion Components In-Space Propulsion
- SENSORS, ELECTRONICS & DEVICES
- Sensors & Actuators Nanoelectronics Miniature Instruments



# CROSS-CUTTING

#### MODELING, SIMULA **TECHNOLOGY & PROCESSING**

Lifecycle

MATERIALS

Environment

STRUCTURES

### Ground Computing

- Software Modeling & Model-Checking Integrated Hardware & Software Modeling Human-System Performance Modeling
- Science & Engineering Modeling Frameworks, Languages, Tools & Standards

· Science, Engineering & Mission Data

Collaborative Science & Engineering

Intelligent Data Understanding

Semantic Technologies

Advanced Mission Systems

· Lightweight Structure

Special Materials

· Lightweight Concepts

Computational Design

Flexible Material Systems

Design & Certification Methods

· Deployables, Docking and Interfaces

Mechanism Life Extension Systems
 Electro-mechanical, Mechanical &

Innovative, Multifunctional Concepts

Design & Analysis Tools and Methods

Intelligent Integrated Manufacturing and

Nondestructive Evaluation & Sensors

Electronics & Optics Manufacturing Process

Reliability / Life Assessment / Health

Reliability & Sustainment

Test Tools & Methods

MECHANICAL SYSTEMS

Micromechanisms

Monitoring Certification Methods

Manufacturing Processes

Cyber Physical Systems

Sustainable Manufacturing

Model-Based Certification &

Sustainment Methods

Loads and Environments

MANUFACTURING

- SIMULATION Distributed Simulation
  - Integrated System Lifecycle Simulation · Corrosion Prevention, Detection, Simulation-Based Systems Engineering & Mitigation
- Environmental Remediation & Simulation-Based Training & Site Restoration Decision Support Systems Preservation of Natural Ecosystems INFORMATION PROCESSING
  - Alternate Energy Prototypes

TA13 GROUN

SYSTEMS PROCESSING

OPERATIONAL LIFE-CYCLE

· Storage, Distribution &

Conservation of Fluids

Autonomous Command &

Vehicle/Ground Systems

ENVIRONMENTAL AND GREEN

TECHNOLOGIES

& Assembly Systems

TECHNOLOGIES TO OPTIMIZE THE

Automated Alignment, Coupling,

Control for Ground and Integrated

- TECHNOLOGIES TO INCREASE RELI-ABILITY AND MISSION AVAILABILITY
- · Advanced Launch Technologies Environment-Hardened Materials
- and Structures Inspection, Anomaly Detection & Identification
- Fault Isolation and Diagnostics Prognostics Technologie
- Repair, Mitigation, and Recovery Technologies

#### Communications, Networking, Timing & Telemetry TECHNOLOGIES TO IMPROVE MIS-

- SION SAFETY/MISSION RISK Range Tracking, Surveillance &
- Flight Safety Technologies Landing & Recovery Systems &
- Weather Prediction and Mitigation Robotics / Telerobotics

## TA14 THERMAL MANAGEMENT

## SYSTEMS

CRYOGENIC SYSTEMS · Passive Thermal Control

Safety Systems

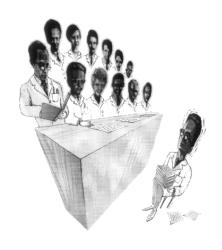
- Active Thermal Control Integration & Modeling THERMAL CONTROL SYSTEMS
- Heat Acquisition Heat Transfer
- Heat Rejection & Energy Storage THERMAL PROTECTION SYSTEMS · Entry / Ascent TPS Plume Shielding (Convective &
  - Radiative) Sensor Systems & Measurement Technologies

# Space Technology Roadmaps STR • TABS **TECHNOLOGY AREA BREAKDOWN STRUCTURE**

# The Solicitation – Application Evaluation and Selection



All eligible fellowship applications will undergo a review by technical experts.



## **Criteria for Evaluation**

**Merit** of the Applicant's Proposed Educational Research Area of Inquiry and Goals

- technical merit as appropriate to the candidate's educational level
- > research area description, knowledge of relevant research literature and plans for student/advisor/mentor partnership

**Relevance** of the proposed research to NASA's Space Technology Roadmaps

## Academic excellence and Potential

- Organizational and analytical skills
- scientific curiosity, creativity, acumen, and success in research appropriate to his/her educational level

**NOTE**: Subsequent to the technical review, candidates deemed excellent will be submitted to the Office of the Chief Technologist at NASA Headquarters for final consideration and selection.



# **Annual Award Values**





| Category   | Maximum value * |
|--|-----------------|
| Student Stipend                                  | \$36,000        |
| Faculty Advisor Allowance                        | \$9,000         |
| On-site NASA Center/R&D lab experience Allowance | \$10,000        |
| Health Insurance Allowance                       | \$1,000         |
| Tuition and Fees Allowance                       | \$10,000        |
| TOTAL  | \$66,000        |

\* from NSTRF12 solicitation

 A fellowship award is issued as a training grant to the student's host university.

 Separate from the awards, the Program has allocated resources to cover mentor time and costs associated with hosting/interacting with the Fellow.

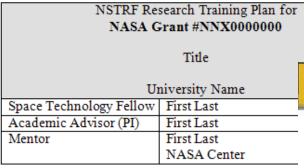
# **Completing the Vision: Mentors**

Lining the future space technology stars up with the best mentors...



# Tying it All Together: Research Training Plan





## **Key Elements of Research Training Plan**

- Cover page (including Abstract)
- Research Description
  - Introduction
    - Goal
  - Background
  - Approach/Methodology
  - Expected Outcome(s)
  - References
- Relevance to NASA
- On-site Experience(s)
- Conferences
- Schedule

Nanotechnology Team Members

**Example (from Game** 

**Briefing) of how NSTRF** 

advisors and students

might appear as team

members on NASA

projects.

**Changing Program** 



- -- Dr. Marisabel Lebron Colon -- Dr. Sandi Miller -- Dr. Tiffany Williams
- -- Dr. Francisco Sola Lopez

-- Dr. Harish Manohara

- -- Dr. Ted Swanson
- · LaRC
- -- Dr. Emilie Siochi -- Dr. Kris Wise
- Others
   -- Nanocomp
- -- Nanocomp -- Lockheed Martin
- -- MIT Brian Wardle collaboration through STRFs
- -- Other universities TBD

This soution is summed

This section is expected to have significant input from the mentor in identifying and elaborating on the ties to not just the Technology Areas and Grand Challenges, but also documenting relevance to ongoing activities in NASA's Mission Directorates.

Research Training Plan: Required by a NASA Space Technology Research Fellowship (NSTRF)

## Purpose:

Will be used by the Program for both internal (to NASA) and external reporting and advocacy.

Sharing portions of these plans fosters an awareness of the variety of activities that are being sponsored within each technology area.

### Instructions and Considerations

- ☐ Should be developed collaboratively by the student Fellow, Academic Advisor, and NASA mentor.
- ☐ Should be based on the original proposal.
- □ Intended to tie the student's research being performed on campus, as part of his/her degree program, with the research to be conducted at the NASA Center or R&D lab.
- □ Submitted (by student) before end of the fall academic term.

# **NSTRF11 Results**

NASA SPACE TECHNOLOGY RESEARCH FELLOWSHIPS (NSTRF) - Fall 2011 Fellowship Start

 Call for proposals...
 December 29, 2010

 Proposals due...
 February 23, 2011 at 11:59 PM ET

 Announcement of new fellowships...
 May 18, 2011 (target)

 Fellowship acceptance deadline.
 May 27, 2011 (target)

 Start date of fellowships...
 August 1, 2011 (target)

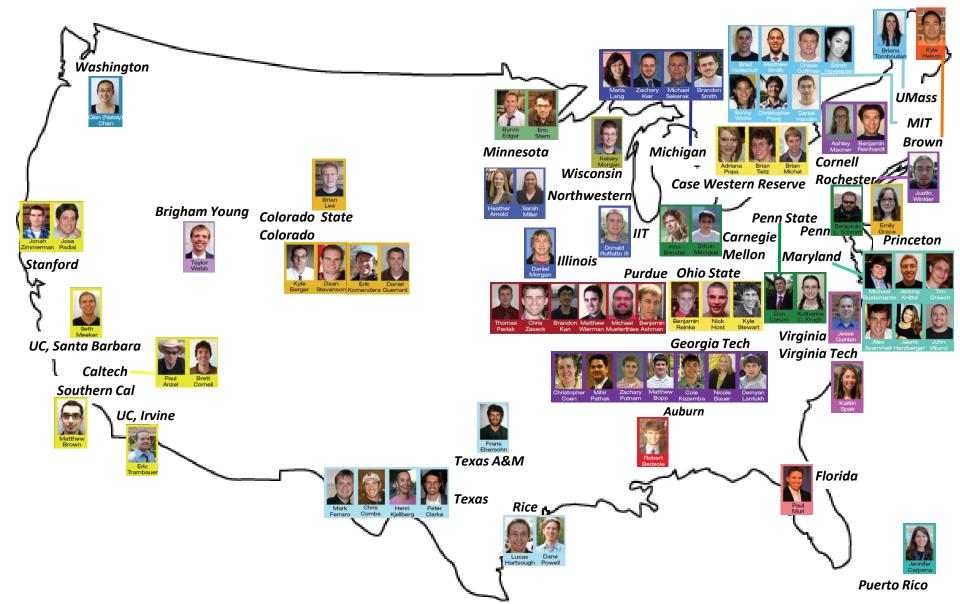
http://tinyurl.com/NSTRF11-OCT

Inaugural call cover page

# **National Asset: The Inaugural Class of NSTRF**

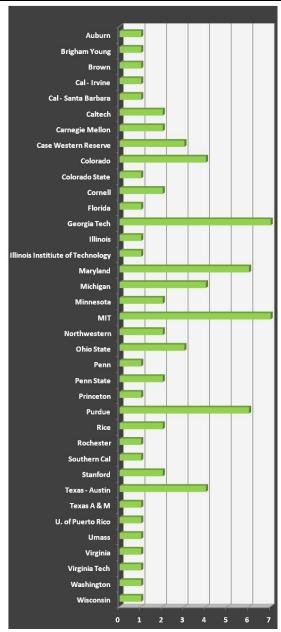


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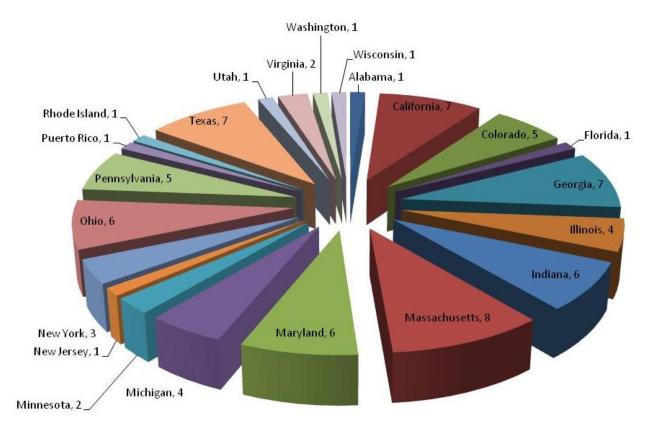
# **NSTRF11 Awards by University and State**





## **Number of Awards by University**

## **Number of Awards by State**



# **NSTRF11 Awards by Technology Area**

















Human Expl. Dest.





































Materials/Structures

**12** 





Launch Propulsion

In-Space Propulsion

Space Power/Storage

3







Sci. Instr./Sensors



回

9















**Ground Operations** 

**TA: 1** 

Robotics

4



















Comm./Navigation

Human Health

6











Nanotechology

10











**13** 



Thermal

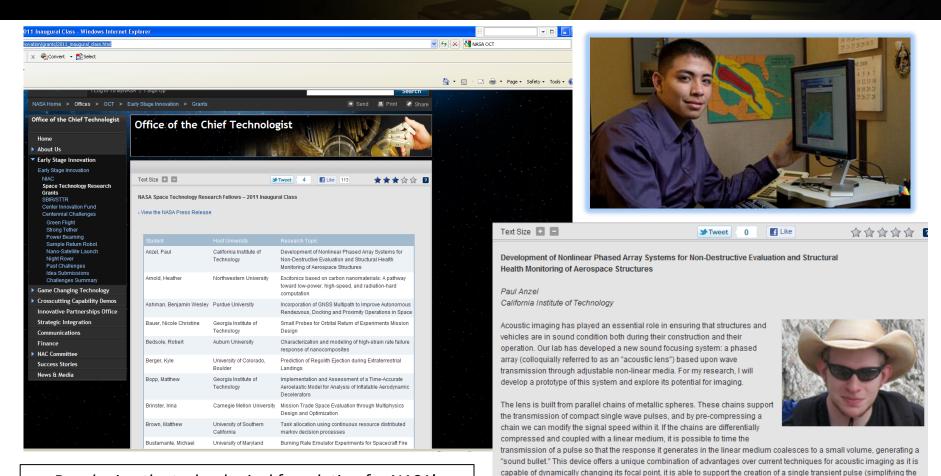




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## Find Out More About the NSTRF11 Awards





Developing the technological foundation for NASA's future science and exploration missions...providing the nation with a pipeline of highly skilled engineers and technologists to improve U.S. competitiveness.

task of signal analysis and possibly allowing for a more accurate result), and it is capable of supporting a powerful signal.

To develop the lens for practical use, three major issues will be addressed in order to determine the boundaries of its performance. First, the limits of where the signal can be focused will be studied. Second, methods to improve transmission of the signal to the linear system will be explored. And third, the limitations of signal power and the degradation of

With these issues addressed, I will construct a prototype of the lens. Once the prototype has been built research will then shift towards applying the lens to imaging. I will first test the ability of the lens to image features within bulk media and then

performance due to plastic deformation of the spheres will be determined.

The full listing of NSTRF11 awarded proposals with abstracts is available on the NASA OCT website at http://www.nasa.gov/offices/oct/early stage innovation/grants/2011 inaugural class.html

# **Summary**



- Inaugural class is in place *impressive credentials*
- Roadmaps are the basis for collaboration
- Research partnerships are being formed
- NSTRF12 solicitation is open we look forward to welcoming the next class of Space Technology Research Fellows

